

Agenda Items: D1

Prepared by: A. Wade  
June 15, 2000

Review of Spacecraft Current On-orbit Performance  
NOAA-15, 14, 12, 11 and 10

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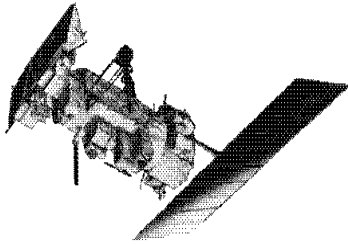
**EXECUTIVE SUMMARY**

NOAA's On-orbit Operational satellites consists of NOAA-15, 14, 12, 11, and 10. NOAA-15 became operational on October 26, 1998 and began operating as the primary morning polar satellite on December 14, 1998. Less than a month on orbit, the high gain S-Band antennas on NOAA-15 began to degrade in performance. Later, all three antennas completely failed due to mechanical design flaws. The malfunctioning antennas caused the science data to become noisy and increased the electromagnetic interference to an already susceptible AMSU-B instrument. A decision was made by NOAA management to use the backup omni antennas on board the satellite but unfortunately, only two omni antenna downlinks were available to perform the downlink transmissions, typically performed by the three high gain antennas. The change in downlink configuration resulted in a reduction of available LAC resources. NOAA-14 is the primary afternoon satellite but due to orbit drift, the environmental products are in danger of becoming useless. NOAA-12 was replaced by NOAA-15 as the primary morning spacecraft on December 14, 1998. Due to a reduction in the NOAA-15 downlink channels as a result of antenna failure, the operational mode of NOAA-12 was changed to semi-operational and is now being used to supplement NOAA-15's LAC and HRPT transmissions. The HIRS filter wheel motor on NOAA-11 became stuck on April 13, 2000 and exceeded its current and temperature operating limits. The instrument was turned off on April 26, the science data was deemed unusable. NOAA-10 is on standby but supports Search and Rescue and Argos.

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**ACTION REQUIRED**

No specific action is required.



# **NOAA POES PROGRAM**

## **On Orbit Satellite Performance**

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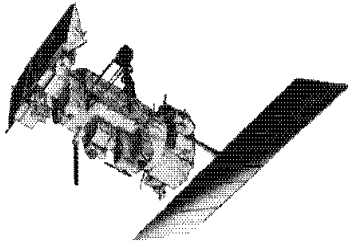
Presented to:

**ARGOS OPERATIONS COMMITTEE CONFERENCE**

**June 27 - 29, 2000**

**Woods Hole, Massachusetts**

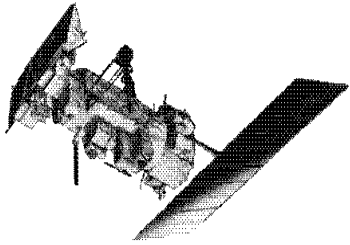
Angelo G. Wade, NOAA/NESDIS/OSD



# TOPICS

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- **STATUS OF OPERATIONAL SATELLITES**
  - NOAA-10 through 15
  - Drift rates and Equator Crossing Times
- **Satellite Constellation Status**
  - NOAA-10 through 15 Instrument and Subsystem Status

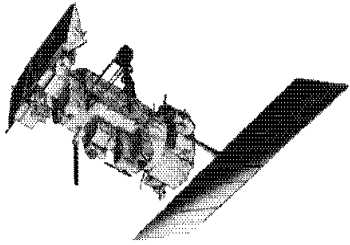


# STATUS OF OPERATIONAL SATELLITES

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- **NOAA-15/K (Launched May 1998)**
  - Primary AM Satellite
  - Back-up antennas providing operational data
  - *DCS fully Operational*
- **NOAA-14/J (Launched Dec 1994)**
  - Primary PM Satellite
  - One of Two CPUs has Failed, *SARP has Failed*, Tape Recorder 4 Inoperable, Tape Recorder 3B Erratic
  - Satellite equator crossing time drift impacting imagery based products

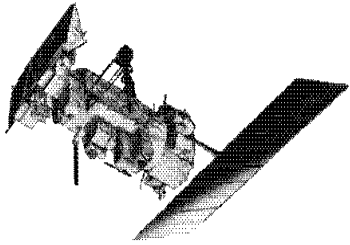


## OPERATIONAL SATELLITES (Continued)

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- **NOAA-12/D (Launched May 1991)**
  - Backup AM satellite
  - Provides HRPT service (for hazards community)
  - APT turned back ON, no longer in conflict with NOAA-15
- **NOAA-11/H (Launched Sept 1988)**
  - HIRS Filter Wheel failed. Instrument turned OFF April 26, 2000
    - Science data no longer usable
  - Supports Search and Rescue Mission
- **NOAA-10/G (Launched Sept 1986)**
  - Standby Mode
  - Stored and Real-time TIP transmissions once per week
    - STIP downlink over Lanion?
  - Supports Search and Rescue Mission and Argos
    - SARP 406 receiver failed 1988



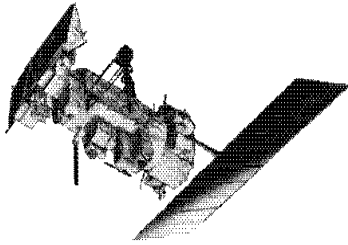
## OPERATIONAL SATELLITES (Continued)



### DRIFT RATES AND EQUATOR CROSSING NODES (ECN) As of June 2000

<u>Spacecraft</u>	<u>Launch Date</u>	<u>Equator Crossing Times</u>	<u>Drift Rate</u>
NOAA-15	MAY 1998	0731 Descending	-0.4 min/month
NOAA-14	DEC 1994	1553 Ascending <sup>1</sup>	+4.0 min/month
NOAA-12	MAY 1991	0523 Descending	-1.8 min/month
NOAA-11	SEPT 1988	2141 Ascending	+2.7 min/month
NOAA-10	SEPT 1986	0436 Descending	-0.1 min/month

<sup>1</sup> NOAA-14 orbit drift is causing concern because of the potential risk of degradation to environmental products.



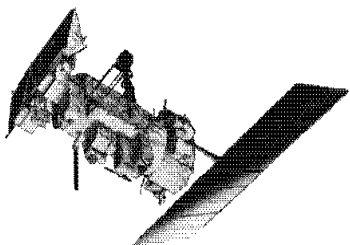
# POES Constellation Status



POLAR ORBITING ENVIRONMENTAL SATELLITE (POES) STATUS May 9, 2000					
NOAA 10	NOAA 11	NOAA 12	NOAA 14	NOAA 15	SUBSYSTEM
G ●	G ●	G ●	Y ●	G ●	C&CS COMMAND & CONTROL SUBSYSTEM
Y ●	G ●	G ●	Y ●	G ●	EPS ELECTRICAL POWER SUBSYSTEM
Y ●	Y ●	G ●	G ●	G ●	ADACS ATTITUDE DET. & CONTROL SUBSYSTEM
Y ●	G ●	G ●	G ●	Y ●	COMM COMMUNICATIONS SUBSYSTEM
G ●	G ●	G ●	G ●	Y ●	THERMAL THERMAL CONTROL SUBSYSTEM
G ●	Y ●	Y ●	Y ●	G ●	DHS (tape recorders) DATA HANDLING SUBSYSTEM

## KEY

RED = Not Operational  
 YELLOW = Operational with limitations (or Standby)  
 GREEN = Operational (or capable of)



# POES Constellation Status



POLAR ORBITING ENVIRONMENTAL SATELLITE (POES) STATUS May 9, 2000					
NOAA 10	NOAA 11	NOAA 12	NOAA 14	NOAA 15	INSTRUMENT
G ● -	G ● G ●	G ● -	G ● G ●	G ● AMSU A G ●	DCS DATA COLLECTION SUBSYSTEM SSU STRATOSPHERIC SOUNDING UNIT
R ●	R ●	G ●	Y ●	AMSU B Y ●	MSU MICROWAVE SOUNDING UNIT
Y ● Y ●	R ● R ●	Y ● G ●	G ● G ●	G ● G ●	HIRS HIGH RESOLUTION INFRARED SOUNDER AVHRR ADV. HI RESOLUTION RADIOMETER
G ●	Y ●	-	G ●	G ●	SARR SEARCH & RESCUE REPEATER
R ●	G ●	-	R ●	G ●	SARP SEARCH & RESCUE PROCESSOR
R ● -	- Y ●	- -	- Y ●	-	ERBE EARTH RADIATION BUDGET EXPERIMENT SBUV SOLAR BACKSCATTER UV RADIOMETER
G ●	-	G ●	Y ●	G ●	SEM SPACE ENVIRONMENT MONITOR

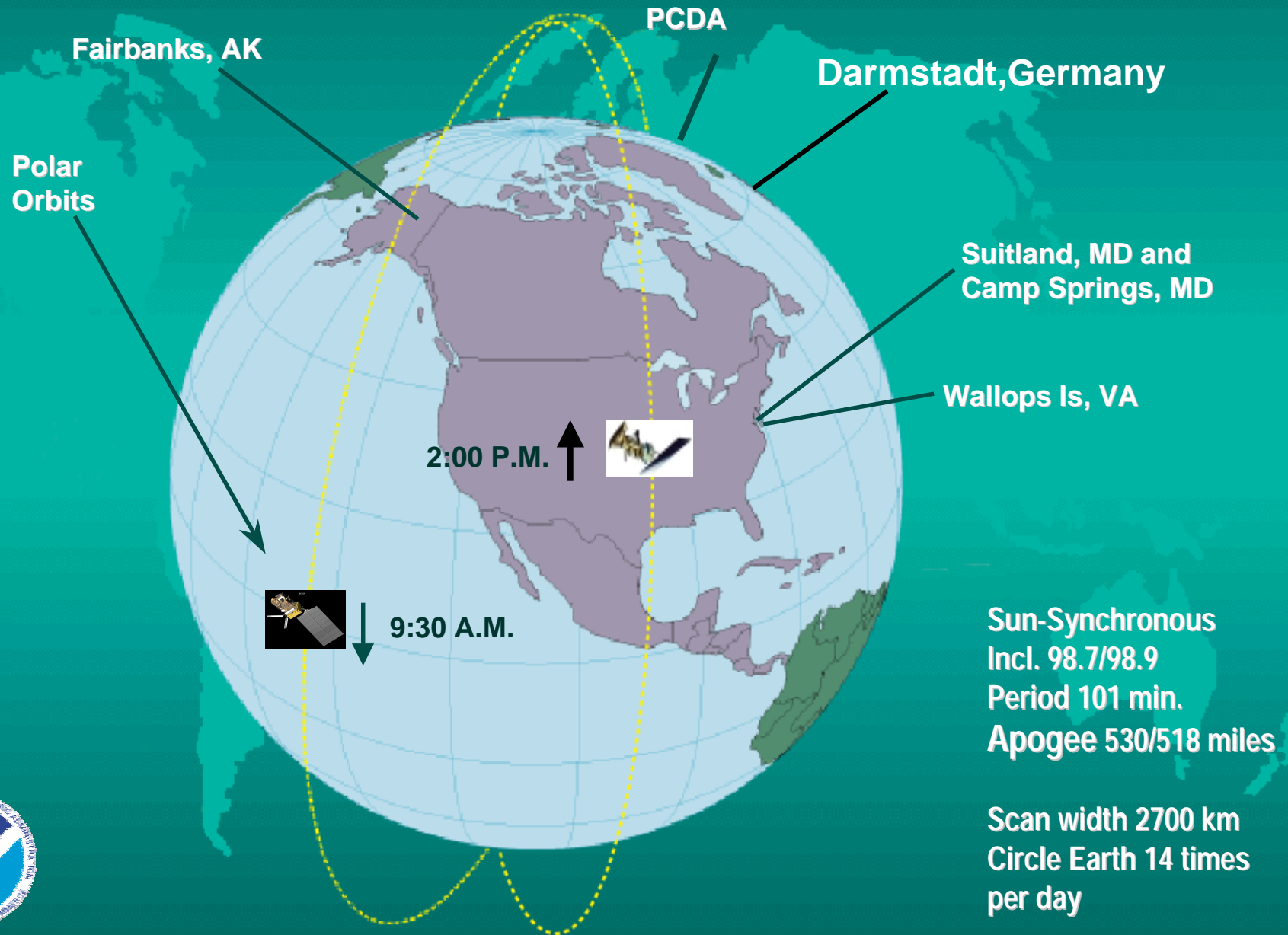
← HIRS turned off on N-11

## KEY

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# IJPS Weather Satellite System - 2005



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### **NOAA-15**

The NOAA-15 satellite was successfully launched at 8:52 PDT/11:52 EDT from Vandenberg AFB on May 13, 1998. NOAA-15 became operational on October 26, 1998 and began operating as the primary morning polar satellite on December 14, 1998. NOAA-15 has replaced NOAA-12 as the primary operational morning descending satellite. The current equator crossing time for this satellite is 0731 local descending node.

**Note: The DCS instrument and all of its Data Recovery Units are fully operational and no anomalies reported.**

In addition, the statuses of all other instruments and subsystems on NOAA-15 are as follows: 1) The AMSU-B instrument still exhibits a scan position dependant warm bias on all channels due to unintentional electromagnetic interference (EMI) produced by the NOAA-15 SARR (Search and Rescue downlink transmitter) and STX-2 (1702.5 MHz) S-Band transmitters. However, since the EMI pattern and emission profile from these S-Band transmitters is constant, therefore, software is used to correct out any biases. 2) The HIRS on NOAA-15 has experience random event fluctuations in its filter wheel current and elevated temperatures in its housing. Preliminary analysis suggests, cause of anomaly could be contamination of bearings in motor or loss of lubricant. All other instruments operating nominally.

The performance of the communications subsystem on NOAA-15 is severely degraded due to the mechanical failure of the high gain S-Band antennas. Typically, three S-Band downlink channels are used for transmission of real-time HRPT, stored LAC, and GAC data. However since September 1999, the downlink configuration has remained as follows; all high gain S-Band antennas are out of commission, two of the high gain antennas have been replaced with omni antennas having lower gain characteristics. Only two S-Band downlinks support the real-time (HRPT) and stored mission data transmissions (LAC & GAC). In, addition, the gyros on NOAA-15 became unstable producing an erratic bias output. On July 14, a series of yaw updates exceeding 0.1° in magnitude occurred. The largest of these yaw updates was -0.786°. Gyro analysis has shown that both Gyro 3's yaw gyro B channel (XB) and roll gyro B channel (YB) had bias shifts, changing in an erratic manner. The gyros used on NOAA-15 are a new type not previously flown. After switching the yaw and roll gyro channels from "B" to "A" on July 21, 1999, (J202), yaw control was normal with no yaw updates exceeding the nominal magnitude of 0.1 degrees. All other subsystems are operating nominally.

### **NOAA-14**

NOAA-14 was successfully launched on December 30, 1994 into an 850 km orbit and is currently designated as the primary operational afternoon satellite. Immediately after launch, engineers discovered a leak from the high to low pressure side of the gaseous nitrogen (GN2) system. Disturbances caused by the venting of GN2 through the nitrogen release valve caused a loss of attitude control. Attitude control was restored when the onboard automatic momentum unloading software was enabled to counteract the attitude

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disturbances caused by the venting, and when automatic thruster firings continued until pressure equalized between the high and low sides of the release valve.

Note, orbit drift of the satellite is causing concern because of the potential risk of degradation to environmental products. NOAA-14 has drifted from its 1330 Local orbital insertion 4.5 years ago and continues to drift at a rate of four minutes per month. The current equator crossing time for this satellite is 1553 local ascending node.

**Note: The DCS instrument and all of its Data Recovery Units are fully operational and no anomalies reported.**

In addition, the status of all other instruments and subsystems on board the NOAA-14 satellite are as follows: 1) The Microwave Sounding Unit (MSU) has been operating nominally since the first anomaly occurred back on March 3, 1995, indicating an unusually high temperature on its scan motor as well as several other areas. 2) **The Search and Rescue Processor (SARP) was commanded off on February 8, 1995 when telemetry indicated the +12V power was near zero.** Since then, every effort to solve the problem has failed and the instrument remains in a failed state. 3) The SARR is operational on side A. The 406-A receiver is 20db lower in gain than expected. 4) The Stratospheric Sounding Unit (SSU) is operating nominally. No anomalies reported since April 1995. On April 29, 1995, telemetry indicated an abnormality in the scan mechanism on the SSU. NOAA's engineers report the SSU scanner position detectors for Earth Position #5 and #6 Reed Switch are intermittent. The SSU science data is not adversely affected. The SSU flying on NOAA-14 is the engineering model, vintage late 1970's. 5) The SBUV is currently experiencing problems with position 4 of the grating drive. Orbital drift of the satellite is causing SBUV products to be unusable. Alternative ozone collection methods are being explored. 6) On April 1, 1999, the NOAA-14 spacecraft switched from the Normal attitude control mode to the Yaw Gyro Compassing (YGC) mode. Preliminary investigation finds that telemetry showed a problem with the Earth Sensor state prior to the mode change. 7) The Space Environment Monitor (SEM) Medium Energy Proton and Electron Detector (MEPED) was powered off for four minutes on May 7, 1999, to attempt to recover two failed channels on the sensor. The recovery attempt did not restore the two failed MEPED channels; however, the instrument is still collecting useful science data. All other systems are operating nominally.

### **NOAA-12**

NOAA-12 was launched on May 14, 1991 into an 825 km orbit. The current equator crossing time for this satellite is 0523 local descending node (launched into a 0732 descending orbit in 1991). NOAA-12 crossed the equator at 91.39° W longitude at 00:06:05 Z on August 01, 1998. The solar angle is 27.6578°. NOAA-12 is currently the backup morning satellite to NOAA-15.

**Note: The DCS system is fully operational.**

In addition, the status of all other instruments and subsystems on board the NOAA-12 satellite are as follows: 1) The Space Environment Monitor (SEM) Total Energy Detector (TED) high-voltage power supply turned itself off on March 7 at 07:18 GMT. The TED appears to have turned itself off due to a low power transient on the In-Flight Calibration (IFC) enable line, causing both high-voltage power supplies to power off. On March 8 at 10:42 GMT, the SEM TED was successfully turned on and resumed normal

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operation. 2) HIRS data is no longer usable for sounding products; operational, but highly degraded.. On May 31, 1997, the HIRS filter wheel experienced a drastic increase in current. The filter wheel is currently operating in what is considered the “end-of-life” mode (HIGH). All other instruments and subsystems are operating normally.

### **NOAA-11**

NOAA-11 was launched September 24, 1988 into an 850 km orbit and became the operational afternoon ascending spacecraft on November 9, 1988. As of April 1999 it is in standby mode. NOAA-11 was replaced by NOAA-14 as the primary afternoon satellite. NOAA-11 has been operational for TOVS data since the NOAA-12 HIRS filter wheel anomaly, however, as of April 1999 it is in standby mode collecting STIP recordings and NOAA’s Satellite Operations Control Center (SOCC) is collecting ephemeris on a biweekly basis. The current equator crossing time for this satellite is 2141 local ascending node (launched into a 1340 orbit in 1986).

**Note: The Data Collection System (DCS) is fully operational on its single receiver. Data Recovery Unit 4 had a low throughput, has been turned off, and is considered failed. The three remaining DRUs are operating normally. Analog telemetry channel 95, DCS receiver gain, showed a 6 dB drop in gain on March 19, 1992.**

In addition, the performance status of other satellite instruments and subsystems are as follows: 1) SARR is operational on side A, the 406-A receiver is 20dB lower in gain than expected, 2) SARP is fully operational in the continuous memory read mode. 3) The AVHRR failed on September 13, 1994). Subsequent tests suggested that a transistor in the H-bridge of the motor power supply may have failed. 4) On April 13, 2000 the NOAA-11 HIRS’ filter wheel exhibited erratic behavior and its current and temperature exceeded the operational limits of the instrument. The filter wheel motor stop moving and SOCC engineers could not unstick the instrument and after several attempts the instrument was turned off April 26, 2000. 5) The MSU motor belt or antenna drive coupling has broken. The channel 3 and 4 reflector is no longer rotating and is believed to be pointing at the earth. Useful channel 1 and 2 data can be obtained only if a reflector pointing orientation analysis is performed. 7) The SSU is operating normally, and 8) As of February, 1999 the SBUV experienced limited grating drive movements and has stuck on occasion resulting in maintenance mode operations .

All other spacecraft subsystems and instruments are functioning nominally.

### **NOAA-10**

NOAA-10 was launched on September 17, 1986 into an 830 km morning orbit. It was placed into a standby status on September 17, 1991, when NOAA-12 became the operational morning satellite. SOCC supports one pass per week for health and safety telemetry monitoring. The current equator crossing time for this satellite is 1636 local ascending node (launched into a 7:30 a.m. orbit in 1986).

**Note: The Data Collection System on NOAA-10 is fully operational and is communicating on Receiver 1. The Data Recovery Units 1, 2, 3 and 4 are functioning nominally.**

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In addition, the operational status of other instruments and subsystems flown on NOAA-10 are as follows:

1) The SARP has failed. The SARP RGR TLM A395 shifted from 84 to 112 dBm on September 9, 1988, indicating a failure of this receiver (TOAR 27602). 3) The SARR is fully operational (Transmitter-A) and is being used by real-time SARSAT users. 4) The HIRS instrument is operating but degraded, the long-wave channels failed in December 1992. 5) On February 11, 1997, the MSU was powered off because telemetry indicated that the digital encoder had failed. All other spacecraft subsystems and instruments are functioning nominally. In addition, realtime TIP is being transmitted via S-Band (1698 MHz) transmitter and stored TIP played back once per week on both mid and high frequency S-Band (1702.5 and 1707 MHz) channels.

The main operational concern for NOAA-10 is the status of the power system. The electric power subsystem has lost many shunt regulators and the solar array has been offset to compensate for excess power. The shunt regulators have degraded to the point that further increases in array offset to accommodate for shunt degradation are not possible. The array is currently offset to 65.0 degrees.